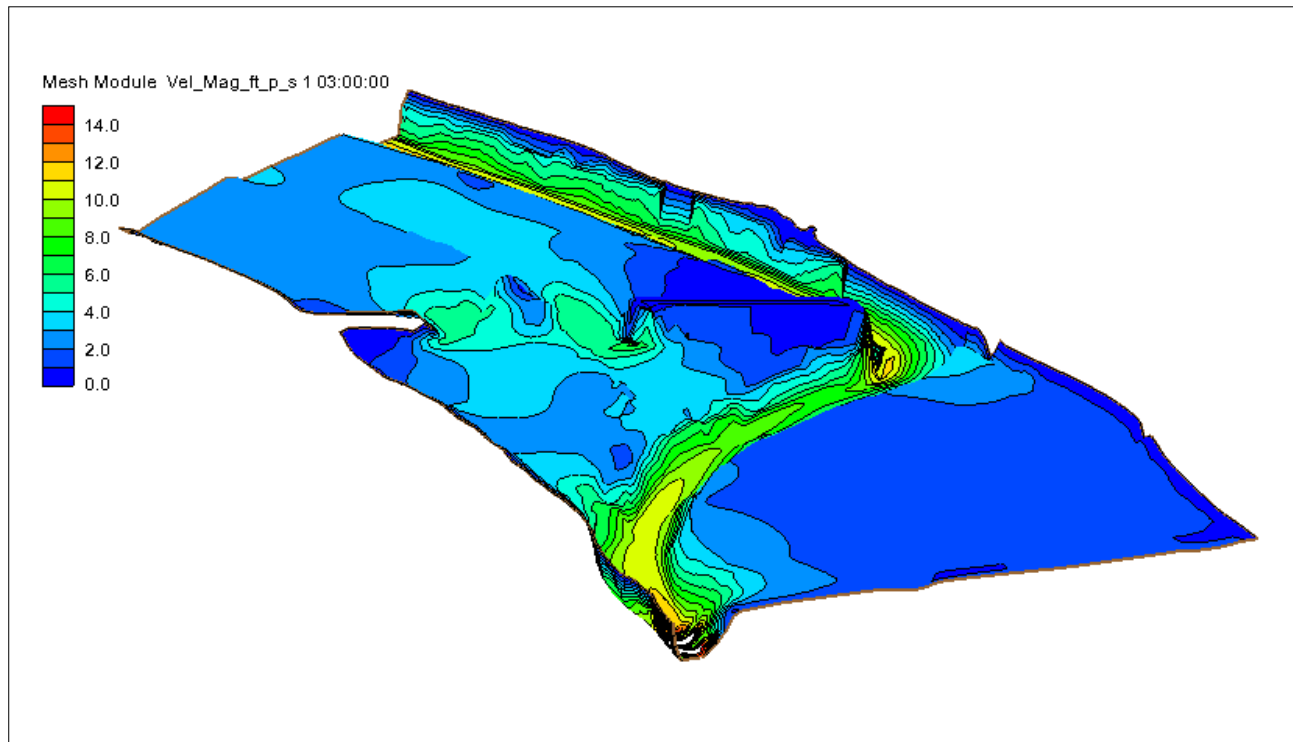




SRH-2D Tutorial

Unsteady Sediment Transport Modeling



Objectives

This tutorial demonstrates how to perform unsteady sediment transport simulations in SRH-2D.

Prerequisites

- SMS Overview tutorial
- SRH-2D
- SRH-2D Sediment Transport

Requirements

- SRH-2D Model
- Map Module
- Mesh Module
- Data files

Time

- 15–30 minutes model setup
- 4–7 hours model run



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1 Introduction

The Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) model is a hydraulic, sediment, temperature, and vegetation model for river systems developed by the United States Bureau of Reclamation (USBR) and sponsored by the United States Federal Highway Administration (FHWA).

For this tutorial, a previously developed SRH-2D sediment transport simulation with steady state flow will be modified to include an unsteady flow. The primary interest for FHWA is in relation to bridge scour, and SRH-2D sediment transport simulations can be very informative for estimating contraction scour, which is essentially an erosion and sediment transport problem. SRH-2D also provides detailed hydraulic output that can be used to estimate pier and abutment scour potential.

1.1 Background

The Cimarron River example used in the SMS “SRH-2D Sediment Transport” tutorial will be use in this tutorial. If needed, review the “SRH-2D Sediment Transport” tutorial before proceeding with this tutorial.

This tutorial will cover defining parameters and properties for an unsteady flow in a sediment transport model including boundary conditions and other input parameters. This tutorial is for instruction purposes and is not intended as an analysis of actual conditions at this bridge crossing.

2 Getting Started

To start this tutorial:

1. Launch the SMS application.
2. Select *File / Open...* to bring up the *Open* dialog.
3. Browse to the file “Cimarron_Sed_Unsteady.sms” located in the *data files* folder for this tutorial.
4. Click **Open** to import the project file and close the *Open* dialog.

This file opens the existing steady state sediment transport model as shown in Figure 1. This project will be modified to perform sediment transport with an unsteady flow hydrograph.

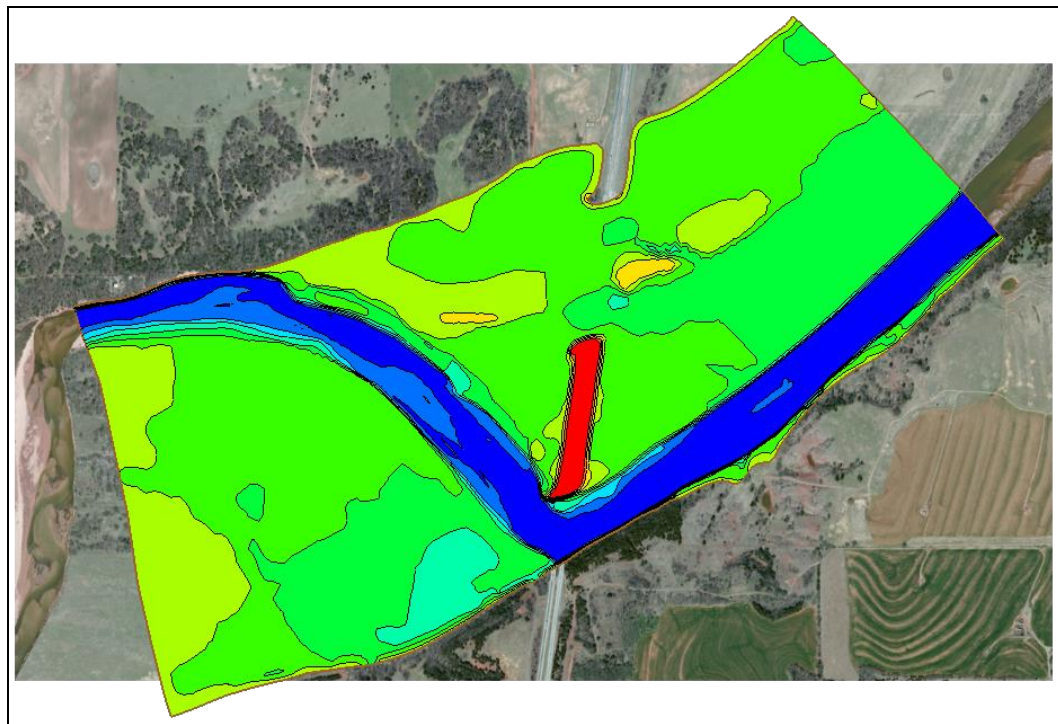


Figure 1 The steady state sediment transport model of the Cimarron River

3 Boundary Conditions

This section outlines the process of setting up an unsteady simulation from the existing steady state simulation. This involves copying the simulation and boundary condition coverages and modifying the parameters of each.

3.1 Creating the Boundary Condition Coverage

The existing boundary condition coverage used in the steady state sediment transport model has most of the parameters defined that will be used in the unsteady state simulation. Therefore, copying the coverage provides a good starting point. To do this:

1. Right-click on the “BC_Sed” coverage and select **Duplicate**. This will create a new coverage named “BC_Sed (2)” that can be used to define the boundary conditions.
2. Right-click on the “BC_Sed (2)” coverage and select **Rename**. Then enter the name “BC_Sed_Unsteady” for this coverage.




The coverage properties set on the “BC_Sed” coverage have now been transferred to the “BC_Sed_Unsteady” coverage along with all feature objects. The values in the *BC*

Type Parameters dialog do not need to be changed from what was previously set. However, the attributes of the feature arcs representing the model boundary conditions do need to change to allow for unsteady flow.

3.2 Assigning Boundary Conditions

Currently the boundary conditions arcs have been defined for steady flow. Adding a time series to the upstream boundary and a rating curve to the downstream boundary will create an unsteady flow.

To assign boundary conditions at the upstream boundary:

1. Select “ BC_Sed_Unsteady” under “ Map Data”.
2. Using the **Select Feature Arc**  tool, double-click on the arc on the left (upstream) side. This will open *SRH-2D Linear BC* dialog.
3. Under *Type*, select “Inlet-Q (subcritical inflow)” option.
4. Change *Discharge (Q)* to “Time Series” and change the units to “hrs-vs-cfs”.
5. Click on the **Define Curve...** button to open the *XY Series Editor* dialog.
6. Click **Import** to bring up an *Open File* browser.
7. Navigate to the *data files* folder for this tutorial and select the file named “Inflow_Hydrograph.xls” then click **Open** to import the file data into the editor.

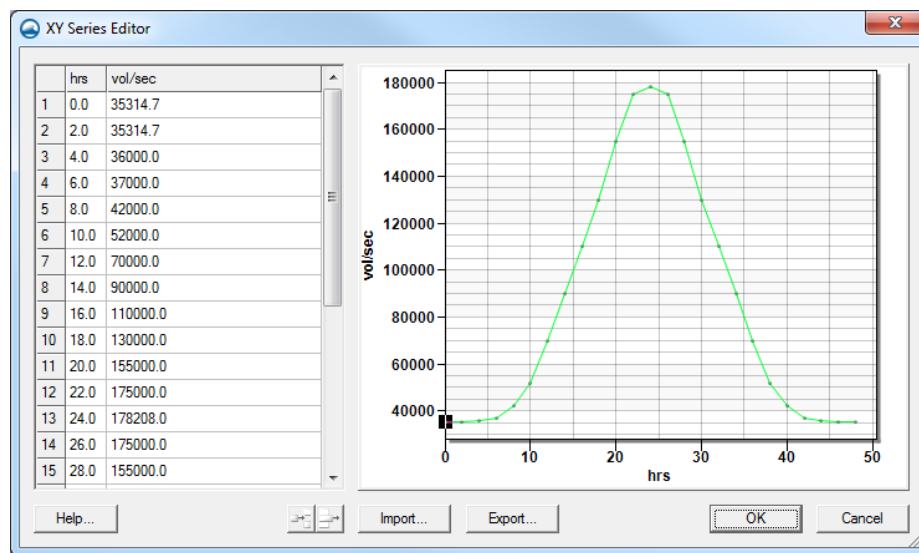



Figure 2 The imported time series in the XY Series Editor

8. Click **OK** to close the *XY Series Editor* dialog.
9. Under *Distribution at Inlet*, select the “Conveyance” option.
10. Under *Sediment Discharge Type*, select the “File” option.
11. Click the **Select** button to bring up a *Choose file* browser.

12. Navigate to the *data files* folder and select the file named “Sed_RC.xys” then click **Open** to import the file.
13. Click **OK** to exit the *SRH-2D Linear BC* dialog.

To assign boundary conditions at the downstream boundary:

1. Click on **Select Feature Arc**  tool and double-click on the arc on the right (downstream) side. This will open *SRH-2D Linear BC* dialog.
2. Under *Type*, select “Exit-H (subcritical outflow)” option.
3. Change the *Water Elevation (WSE)* to “Rating Curve”; change the *Q vs WSE* unit to “cfs-vs-feet”.
4. Click the **Define curve** button to bring up the *XY Series Editor* dialog.
5. Click on the **Import** button to bring up an *Open File* browser.
6. Navigate to the *data files* folder and select the file named “WSE_RC.xys” then click **Open** to import the file data.

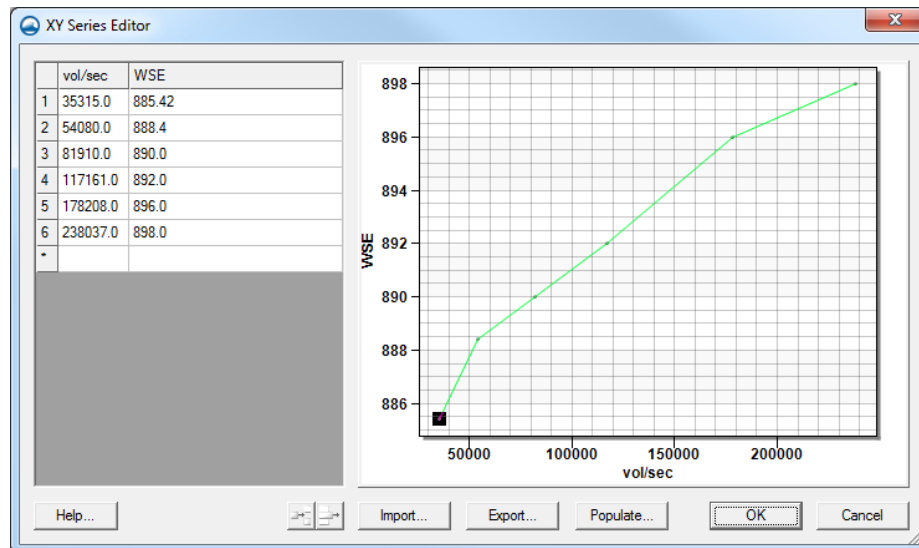




Figure 3 The imported rating curve in the XY Series Editor

7. Click **OK** to close the *XY Series Editor* dialog.
8. When done, click **OK** to exit the *SRH-2D Linear BC* dialog.

4 Defining the SRH-2D Simulation

Many of the properties and components that were used in the “Sed_Steady_State” simulation can be used for the unsteady flow simulation. To save time, the steady state simulation can be copied and modified for unsteady flow.




To copy a simulation:

1. Right-click on the “ Sed_Steady_State” simulation and select the **Duplicate** command. This creates a copy of the simulation with its model parameters and components.
2. Right-click in the “ Sed_Steady_State (2)” simulation and select the **Rename** command. Enter “Sed_Unsteady” as the new name.

4.1 Linking Components

Most of the components needed for the simulation are already linked since they were copied from the steady state simulation. However, the boundary condition coverage component needs to be changed.

Change the boundary condition component by:


1. Right-click on the “ BC_Sed” item under the “ Sed_Unsteady” simulation and select **Unlink**.
2. Right-click on the “ BC_Sed_Unsteady” coverage and select the *Link To | SRH-2D Simulations* → **Sed_Unsteady** command.

All the necessary components are now linked to the simulation.

4.2 Assigning SRH-2D Parameters

The steady state model parameters were also copied. Most of these parameters will work for the model run, but a few of the parameters must be changed.

To do this:

1. Right-click on the “ Sed_Unsteady” simulation and select **Model Control...** to bring up the *SRH-2D Model Control* dialog.
2. Select the *General* tab and change the following:
 - a. Set the *Simulation Description* to “Unsteady Sediment Transport”.
 - b. Set *Case Name* to “Sed_Unsteady”.
 - c. Set *End Time (hours)* to “48”.
 - d. Set *Initial Condition* to “Restart File”.
 - e. Click the **Select** button to bring up a *Choose file* browser.
 - f. Navigate to the *data files* folder for this tutorial and select the “Q35k_RST.dat” file, then click **Open** to set the file as the restart file.
3. Leave all the parameters under *Flow tab* as currently set.
4. Select the *Output* tab and change the following:
 - a. Set *Result Output Frequency (hours)* to “3” (i.e. 3 hours).
5. Click **OK** to close the *SRH-2D Model Control* dialog.
6. Save (**Ctrl + S**) the project.

4.3 Running SRH-2D

Since running sediment transport models is a long process, this section can be skipped to save time. The solution files have been provided for the next section.

Note: Sediment transport simulations require significant computation power. Any computer system with hardware less than the recommended system for running SMS will not be able to complete an SRH-2D sediment transport simulation.

To run the model:

1. Right-click on the simulation and select **Save, Export and Launch SRH-2D**.

This command will save the SMS project, export all necessary files for PreSRH-2D, run the preprocessor and then run SRH-2D.

This model takes approximately 4 to 7 hours to run.

Once the run is complete, SRH-2D will display a completion message.

2. Click **Yes** to close the console window.
3. Click **Load Solution** to load the solution into the project.
4. Click **Close** to close the model wrapper.

4.4 Viewing SRH-2D Output

Use the visualization tools within SMS to evaluate the results.

If the model run was skipped to save time, import the solution file by doing the following:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Browse to *data files\Solution\Sed_Unsteady_Final\SRH-2D\Sed_Unsteady* folder for this tutorial and select the “Sed_Unsteady_XMDF.h5” file.
3. Click **Open** to close the *Open* dialog and import the solutions file.

See the visualization tools in SMS, as described in the “Data Visualization” tutorial, to evaluate the solution created by the SRH-2D model.

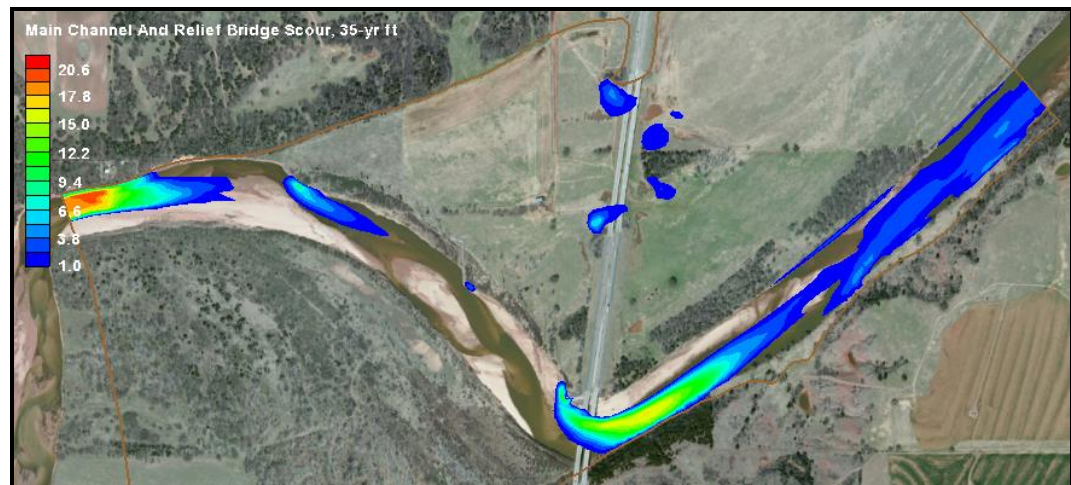


Figure 4 Erosion at the end of the unsteady flow sediment transport simulation

5 Conclusion

This concludes the “SRH-2D Unsteady Sediment Transport Modeling”¹ tutorial. This tutorial demonstrated:

- Setting an SRH-2D boundary conditions coverage to use unsteady flow in a sediment transport simulation .
- Defining an SRH-2D simulation for unsteady flow in a sediment transport simulation.

Continue to experiment with the sediment transport options for SRH-2D in SMS or exit the program.

¹ This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.